What is the condition of the Upper Green River watershed?

Description

The Upper Green River drains approximately 5,413 square miles of south central Kentucky and about 454 square miles of north central Tennessee. This region contains many karst flow systems that affect underground water movement and quality. This area includes all or part of 19 counties in Kentucky and part of 3 counties in Tennessee. Cities in the basin include Bowling Green, Campbellsville, Columbia, Elizabethtown, Franklin, Glasgow, Greensburg, Hodgenville, Munfordville, and Russellville plus numerous smaller communities. Major impoundments in the basin include Green River Lake, Barren River Lake, Nolin Lake, Herndon Lake, Lake Malone, and Lake Beshear.

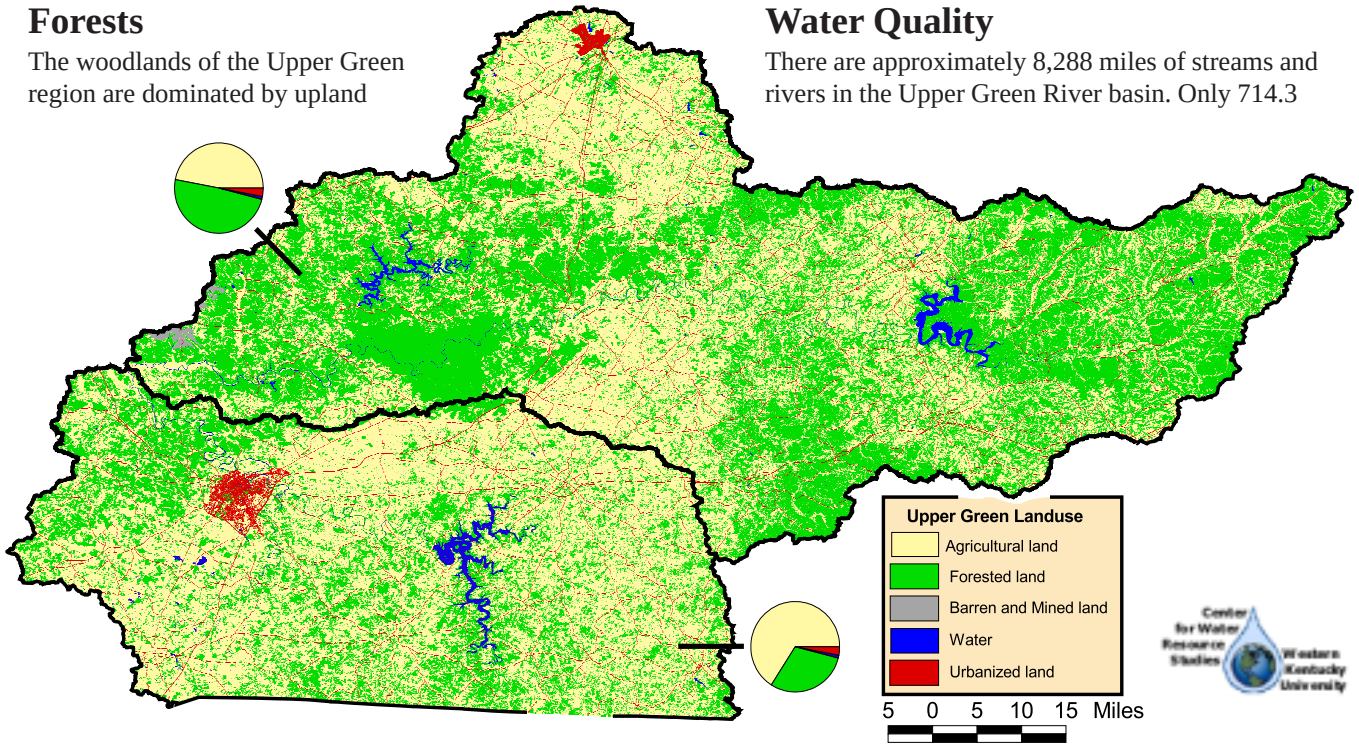
Forests

The woodlands of the Upper Green region are dominated by upland hardwood tree species particular to oak-hickory forests. The variations in soil types throughout the basin influence the vegetation communities. For example, because much of the soils of the Upper Green are well-drained upland soils that originated from limestone, chinquapin oak forests grow well in this region. The woodlands of this region play a pivotal role in water quality, as they help filter pollutants before they enter the many sinkholes and underground rivers and streams in the area. As with the Lower Green, the timber in this area provides important economic benefits. Due to the amount, quality, and maturity of timber here, there are a number of wood-using industries in the watershed that generate numerous jobs throughout the area.

Water Quality

There are approximately 8,288 miles of streams and rivers in the Upper Green River basin. Only 714.3

Bottomland hardwood forest



The American Cave Conservation Association (ACCA), in partnership with the city of Horse Cave and numerous contributors, has established the American Cave Museum, which provides the nation's only museum devoted heavily to cave and karst issues. This is a success story which is providing ongoing educational outreach in the Green River watershed. The ACCA, in cooperation with the Ky. Division of Conservation, operates "Farming in Cave Country," an educational program in the Mammoth Cave area targeted at farmers. Other champions of environmental protection efforts in the Green River basin are the Kentucky Waterways Alliance, Western Kentucky University's Center for Cave and Karst Studies, and its Center for Water Resource Studies

miles (9%) have been assessed to determine whether they meet water quality standards for swimming and fishing. Many of the streams in the upper watershed are relatively pristine, but others have been negatively impacted by agriculture and development, while the lower watershed has been impacted by resource extraction such as coal mining, oil and gas well development, and timber harvesting, as well as poorly planned development and other nonpoint source pollution. The limited monitoring data available in the Upper Green River basin indicates that streams have documented impairments due to agriculture (98.3 miles of stream impaired), industrial and municipal wastewater discharges (61.5 miles), urban runoff and development (17.9 miles), and other unknown sources (394.7 miles). A more detailed listing of streams and where the pollutants are coming from is provided at the center of this document. The centerfold map depicts the location of streams and their impairment status.

Agriculture

The Upper Green River basin includes the headwaters of the Green River and Barren River basins as far west as the edge of the Western Kentucky Coalfields. Agricultural production in this basin is very diversified with land uses devoted to specialty crops including tobacco, livestock production of beef and dairy operations, and conventional row crops of small grains, corn, and soybean production. Based on statewide statistics for 1999, the county with the top cash receipts for tobacco was Barren County in 1999. Barren County was also ranked as Kentucky's number one county in dairy livestock and milk production and ranked number nine in cash receipt sales for crops and beef livestock. Adair County was ranked number two in milk production. Warren County was ranked second in all cattle and calves, second in beef cows, and fifth in milk production (Kentucky Agricultural Statistics 1999-2000).

Row crop agriculture in Green River Basin

Karst Landscapes and Aquifers

Karst landscapes and their associated aquifers are very important features in parts of the Green River Basin. These are areas of soluble limestone bedrock where the bedrock has dissolved, leading to the development of caves, sinkholes, sinking streams, and underground rivers. Indeed, the Green River Basin contains some of the world's most famous and well-developed karst areas, including the longest known cave, the Mammoth Cave System. Due to the spectacular nature of karst development within the basin, parts of Hart, Barren, and Edmonson counties have not only been protected with the establishment of Mammoth Cave National Park, but have been designated by the United Nations as a World Heritage Site and International Biosphere Reserve. In this area, more than 497 miles of cave passages and underground rivers have been explored and mapped, including more than 310 miles in Mammoth Cave alone, far more than any similar sized area on Earth.

Within the Green River Basin, contaminants can be introduced to karst groundwater from urban, industrial, and agricultural sources. Nowhere is this a more significant concern than in the sinkhole plain. The sinkhole plain extends from Hart County, to the northeast, through the Mammoth Cave National Park, into Logan County, to the southwest. An especially severe and widespread problem is bacterial contamination from human and animal waste. Because of the high velocities in a karst aquifer, groundwater contaminated by septic tanks or feedlot runoff can travel long distances to a well or spring with insufficient time for potentially harmful bacteria to die. A particular irony is that while many people have the idea that limestone cave and spring water is often very pure, in reality bacteria levels in karst areas can exceed drinking water standards by thousands of times.

A critical aspect of groundwater in these areas is that unusual and fragile species, and related underground ecosystems, have evolved within the underground rivers of the karst aquifers.

Many of these organisms, including several species of eyeless fish and crayfish, have developed special characteristics to be able to survive in a lifetime of total darkness. While some have lost the ability to see, they have compensated with special sense organs that allow them to move around and find food. Pollution sources, however, pose a significant threat to the health of these ecosystems and their inhabitants. The federally endangered Mammoth Cave Shrimp was thought for some years to have become extinct, but still lives in small numbers in the groundwaters of the Green River Basin. Other endangered species in the watershed, particularly mussels in the Green River itself, are subject to threats by water quality impairment.

Significant research is underway in the basin to develop karst-sensitive Best Management Practices (BMPs), which are land-use strategies that strive to strike a balance between minimizing impairment to the basin's water quality and the economic and cultural needs of the area's residents. Some of these are strictly win-win propositions. Storage and carefully timed application of animal waste as a fertilizer, for example, has in some cases been shown to simultaneously reduce the levels of bacteria entering the groundwater and reduce the need for expensive chemical fertilizers.

Karst sinkhole plain

Special Resources

Nature Preserves within the watershed include the Vernon-Douglas State Nature Preserve. This area is managed by the Kentucky State Nature Preserves Commission to protect resident plants and animals, including many threatened and endangered species. The Kentucky Department of Fish and Wildlife Resources is the regulatory agency responsible for managing rare and endangered species within the state. Twenty stream segments within the Upper Green basin, totaling 665.5 stream miles, contain rare species.

There are two state parks in the Upper Green basin: Green River Lake and Barren River Lake state parks. Both of these state parks have state wildlife management areas associated with them. The Kentucky Department of Fish and Wildlife Resources administers these areas.

A large segment of the Upper Green River has been designated a state Wild River in recognition of its outstanding natural qualities and pristine setting. The designated stream segment is the highest quality, least-impacted stream in the basin. It consists of 26 stream miles of the Green River (Hart and Edmonson counties) and has a corridor area of 6,500 acres. This is part of a larger 157-mile segment, from Green River Lake Dam to Lock & Dam #4, that winds through Taylor, Green, Hart, Edmonson, Warren, and Butler counties. This stream segment is managed by the Division of Water to protect its natural features and undeveloped character. In addition, Mammoth Cave National Park, managed by the National Park Service, also protects much of the Wild River segment of the Green River in Edmonson County, as well as portions in Hart County. Portions of four streams have been designated as Outstanding Resource Waters: a 15-mile segment of the Barren River from Lock and Dam #1 (Warren County) to its confluence with the Green River (Butler County); a 4-mile segment of Echo River (Edmonson County) from east edge of Mammoth Cave National Park to Green River; an 8-mile segment of Hawkins River, an underground flow from Park City (Barren County) to Green River at Turnhole Bend Spring (Edmonson); and a 4-mile segment of Logsdon River from east of Roppel Cave near Cave City (Barren County) to Hawkins River (Edmonson County).

What does the presence of karst mean for water quality?

- Waters in karst areas are extremely vulnerable to contamination.
- While groundwater may travel only a few feet per year through sandstone, it can reach velocities of several miles per day in karst aquifers.
- Stormwater runoff may carry contaminants directly into caves without any filtration through the soil.
- Contaminants may percolate through the thin soils into the cave drainage system below.

Due to the ease with which contaminants can be introduced into, and rapidly carried through, karst aquifers, it is generally safe to assume that <u>any</u> water entering karst aquifers has the possibility of introducing contaminants.

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Northern red-bellied salamander

Threatened freshwater mussels.
Top: fanshell; bottom: rough pig toe

Species of Concern

Federally listed endangered animal species known to occur in the Green/Tradewater River basin include the bald eagle, Indiana bat, gray bat, Interior least tern, fanshell, catspaw, Northern riffleshell, pink mucket, ring pink, Orange-foot pimpleback, clubshell, fat pocketbook, rough pigtoe, American burying beetle, and Kentucky Mammoth cave shrimp. The bald eagle is also the only federally threatened animal species known to occur in the basin. Federally listed threatened plant species known to occur in the basin are Price's potato bean and Eggert's sunflower.

Exotic Species

The zebra and quagga mussels pose a realistic threat to the continued diversity of native unionid mussels and snails in the Green/Tradewater River basin. These invasive, non-native mussels attach themselves to any available hard surface, including water plant intakes and discharge structures, which can become heavily encrusted with these barnacle-like infestations. Frequently required removal of the mussels increases maintenance costs, which get passed on to drinking water customers. Additionally, these exotic mussels attach themselves to other mussels and snails, causing harm to the hosts by restricting their ability to move about and feed themselves. Exotic species often have no natural predators and can continue to reproduce to levels that will displace and out-compete other species.

Barren River

Freshwater Mussels

Historically, the Green River supported one of the most abundant and diverse freshwater mussel faunas in the world. More than 70 species of mussels once flourished in the riffle and shoal habitats of the Green River and its tributaries. Recent surveys of the river from Lock and Dam 6 upriver to Munfordville indicate that 50 species still exist, including 8 species that are currently listed as federally endangered. Although significant reductions in the fauna have occurred, the Green River still supports one of the best remaining native mussel faunas known in the nation.

Because mussels feed by filtering particulates from the water column and because they tend to accumulate pollutants, including heavy metals and organic compounds such as pesticides, they can serve an important role as biological indicators of water quality.

The decline in diversity of freshwater mussel species in the basin can be attributed to infrastructure development (roads, dams, locks, etc.), agriculture, surface and underground coal mining, oil and gas drilling, impoundments, channelization, commercial mussel harvesting, gravel mining, and exotic species.

Waste and Wastewater

Proper management of wastewater is a major issue in the Upper Green basin. Kentucky Pollutant Discharge Elimination System (KPDES) permits, provided for under federal and state laws, allow the disposal of treated effluent into the water. This effluent can be relatively clean wastewater from properly operating municipal and industrial wastewater treatment plants, discharges from sedimentation or treatment ponds near mines or oil/gas wells, or stormwater from culverts that drain city streets.

Most rural households in the Upper Green basin are not connected to municipal wastewater treatment systems and therefore rely on some form of onsite treatment for wastewater. Few municipal wastewater treatment systems presently exist except in some of the larger communities. However, numerous households in the Upper Green basin do not have any form of wastewater treatment, and the untreated wastewater from these households is discharged directly to a creek, onto surface soil, or into underground cavities. This is known as a "straight-pipe" discharge.

The presence of straight-pipe discharges and failed septic

systems has greatly impacted water quality in the Upper Green basin. Elevated levels of fecal coliform bacteria (from human and animal waste) have been detected in numerous portions of the basin. Moreover, the levels of fecal coliform bacteria are so high that numerous streams and creeks are unsafe for swimming or any other human contact, such as wading and fishing.

The passage of Senate Bill 18 in 1998, which requires that a wastewater treatment system be approved prior to electrical hook-up, has slowed the proliferation of straight pipes. Other state and federal resources, in the form of loans and grants, are becoming available to help with this problem (see the end of this document for contact information).

The good news is that people are working together to make a difference through the efforts of various volunteer organizations and participating local governments. During 1998 and 1999, various groups adopted streams for cleanup. In addition, 1,179 open dumps have been identified. These efforts have resulted in 3,315,000 tires being collected from the drainage areas of the Upper Green River Basin and sent to a recycling facility. A major success story is the $15 million effort by local taxpayers, EPA, and other federal agencies to build a regional sewage treatment system for Horse Cave, Cave City and Park City. This has contributed substantially to the quality of water that enters the Green River through the largest spring in Kentucky.

How do we determine watershed health?

Healthy watersheds produce clean water – water that is fishable, swimmable and suitable as a drinking water source. Watersheds that meet these criteria support a wide variety of aquatic life and are a valuable resource. State agencies primarily use the guidelines in the federal Clean Water Act to determine whether or not the quality of river and stream water is acceptable. Under the Clean Water Act, states set standards for the water based on how it is being used. These uses can consider the high-quality values of a wild and scenic river, a stream's importance as a drinking water source, wildlife habitat, or other uses. The standards include benchmarks for various parameters like dissolved oxygen, temperature, acidity, and other measurable qualities (see side-bar).

If a lake, river, or stream meets the standards for fishing, swimming, and drinking water sources, it is said to fully support its designated uses (see centerfold map and tables). If it falls short on a few measures, it may only partially support its uses. Failure on additional counts can mean that it is not supporting its designated uses. The condition of these waters is reported to Congress as required by the Clean Water Act, Section 305(b). Bodies of water that do not support their designated uses must have cleanup plans that identify and quantify the problem pollutants and specify how they will be reduced. Sometimes the pollutants come from point sources such as residential and industrial wastewater treatment systems; other times they are carried into the water from nonpoint sources such as runoff from towns, farms, new developments, or other areas.

Watershed health means more than good water chemistry. In addition to chemical analyses, watershed health can be measured by observing plant and animal life. For example, certain species are indicators of water quality. Also, habitat is important to watershed and stream health. Vegetation in the riparian area - especially shrubs and trees - provides food and cover for terrestrial and aquatic life. Riparian vegetation also holds stream banks in place and helps to filter soil erosion and other polluted runoff. The amount and type of vegetation along a stream, lake, or sinkhole determines riparian health.

Watershed health also means having good storage and retention capabilities in the basin. That is, under ideal conditions, as rain falls upon the earth, water either evaporates, soaks into the ground, or runs off into streams, lakes, and rivers. For water to soak into the ground, the water must encounter some obstacles that slow its flow-rate, such as retention basins, trees, leaf litter in a forest, even grass. All these things cause water flow to slow down enough for it to soak into the ground. A hard-packed clay field or a parking lot will simply shed the water, forcing it to run downstream. Conversely, if the water can soak into the ground, it recharges the groundwater for wells and will slowly release it to our streams and lakes. In an unhealthy watershed, this runoff/

Septic Systems

Septic systems help clean up sewage from homes and businesses in areas not served by wastewater treatment plants. On most systems, the first stage of treatment is the septic tank, where wastewater is digested and solids settle out. After the septic tank, the liquid waste is directed to a drain field, lagoon, or wetland for further treatment. If the process is working correctly, the relatively clean wastewater then soaks into the ground. Septic tanks require periodic maintenance pumping.

Septic system installation

Organisms as indicators
Healthy streams have low levels of contaminants and contain a diversity of plants and animals. Certain mussels and insect larvae (caddisfly, stonefly, mayfly) are often used as indicators of good water quality, similar to the coal mine canaries used to detect poisonous gases. Since these mussels and larvae can live only in relatively clean water, their presence usually indicates that problems are few in that section of the stream.

Kentucky Water Quality Standards
The following parameters, or measurable criteria, are only a few of those used to define Kentucky's water quality standards. The standards and units for each parameter are listed below. For example, if a water sample shows more than 400 fecal coliform CFUs in a 100-milliliter sample, the water would be considered contaminated.
• Dissolved Oxygen: >4.0 Milligrams per liter
• pH (measures acidity): 6-9 Standard units (7.0-neutral)
• Fecal coliform: 400 Colony-Forming Units per 100 milliliters of water
• Temperature: ≤89 degrees Fahrenheit

soak-in cycle can have two negative effects: In times of high flow, it can cause all the water to run off so rapidly that it results in flooding. Or, in times of low flow, it can result in streams that run completely dry because there is no runoff or spring seepage to keep the rivers flowing.

During times of low stream flow, which occur more often in the late summer and early fall, streams may have less suspended silt but may be rich and green from algae growth. During times of low flow, most of the water in streams comes from groundwater inflow.

While state officials have information from samples collected on the Green River, the Tradewater, and the minor tributaries to the Ohio River, much of the water in the basin has not been tested. An interagency workgroup is coordinating efforts to increase the amount of monitoring conducted in the region. By working together, tax dollars can be stretched and better information provided on the condition of the watershed. Also, citizens active in the Tradewater/ Lower Green River Watershed Watch and the Upper Green River Watershed Watch have collected data to supplement public agency information and raise public awareness. Watershed Watch volunteers are trained to conduct habitat and biological assessments, perform regular field chemistry measurements, and take specific chemical samples of their site to a lab for analysis. Reducing concentrations of pollutants that exceed state standards will require a considerable amount of cooperative action and analysis.

Land activities that can impact water quality

Activity	Impacts
Row cropping	Siltation, erosion, chemical and fertilizer runoff.
Livestock production	Manure runoff (excessive nutrients and bacteria), damage to streamside vegetation, bank erosion.
Logging	Loss of streamside trees, bank erosion, siltation from roads, increased runoff.
Mining	Acidity and sulfates from iron sulfide rocks, sediment, runoff surges.
Oil and gas drilling	Brine from drilling, sediments, oily runoff.
Residential yards	Lawn and garden chemical and fertilizer runoff, higher runoff velocities.
Urban development	Siltation from land clearing, runoff surges (oils and metals) from roofs, roads, parking lots.
Industrial facilities	Chemical runoff from material storage areas, soot deposits, runoff surges, spills.
Commercial development	Runoff surges (oils and metals) from parking lots, roofs; sediment from land clearing.
Stream clearing	Sedimentation, loss of wildlife/mussel habitat, loss of shading (increased temp.), flooding.
Channelization	Increased flooding, sedimentation, loss of fish/insect habitat, loss of mussel beds.
Construction in floodplains	Increased flooding, siltation, danger to life and property.
Boating	Fuels, oils, and pathogens from discharge of sanitary waste.
All terrain vehicles (ATVs)	Erosion, loss of habitat.